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A DESCRIPTION

OF

SEVERAL INSTRUMENTS

FOR

Measuring a Ship's Way through the Water.

[Price Two Shillings.]

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FOR

Measuring a Ship's Way through the Water.

By R. H. GOWER,

IN THE INDIA SERVICE.

WITH

AN ACCOUNT

OF

HIS PATENT PERPETUAL LOG,

AND

HOW THE SAME PRINCIPLE MAY BE APPLIED TO SHEW THE ABSOLUTE VELOCITY OF THE WIND, AND THE DEPTH OF THE SEA,

(Letters Patent No. 1895 of 1792)

LONDON:

PRINTED FOR THE AUTHOR;

AND SOLD BY GILBERT AND WRIGHT, NO. 148, LEADENHALL STREET, (THE SOLE MAKERS AND VENDERS OF THE PATENT LOG); SEWELL, CORNHILL; ELMSLEY, STRAND; AND T. AND J. EGERTON, WHITEHALL.

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A DESCRIPTION, &c.

FROM the great inaccuracy in the preſent mode of meaſuring a ſhip's way through the water, the minds of ingenious men have been turned to the improvement of the log, or the adoption of ſome other principle more likely to prove efficient. The moſt that can be expected, is an inſtrument that will ſhew the diſtance paſſed over the *ſurface of the ſea*, as it does not ſeem probable that the ſpace paſſed over the *earth's ſurface* can be aſcertained; though M. Bouguer has propoſed a log for that purpoſe, upon the ſuppoſition that the water, at a certain depth, is not affected either by currents or ſwell. Was this the caſe, there would be leſs need of obſerving the heavenly bodies to find the ſhip's place; but as under currents are frequently met within ſoundings, and as it is known that fluids under different preſſures muſt give way to re-

 ſtore

ſtore the equilibrium, the ſuppoſition appears to me erroneous. How often do we find at ſea a *ſet* given by obſervation differing from the current found by experiment; and the obſervation agreeing with the account, without allowing the current given by experiment! which is a proof that the current muſt have been beneath the ſurface. For example, ſuppoſe the water ſhould be tranquil at the ſurface, and at the depth of 50 fathom is running north at the rate of one mile per hour, it is plain that if a pitch-pot be let down to that depth, and the line made faſt to the bow of the boat, the pot will pull the boat along north one mile: and the people in the boat ſuppoſing her ſtationary, will ſay, "The water paſſes her, running ſouth a mile per hour;" from which conſideration I have made it a rule, never to allow the current given by the above method.

To make a perfect log, the firſt idea that preſents itſelf is, the producing a line the length the ſhip has ſailed; a thing not eaſily attained. Who but would ſmile to ſee the log hove over-

board

board at twelve to run till one! An imaginary line, however, may be collected upon the following principle. *If a hole were made in the bow of a ship, the water would rush in as fast as the ship sailed, augmented by the quantity forced in through the pressure of altitude.* Now if, instead of a hole in the bow of the ship, a vessel, or instrument with a hole in its front, were drawn after the ship, the water would pass into this vessel as fast as the ship sailed, increased by the pressure arising through its depth, which being deducted from the whole quantity of water found in it, would leave the sum sought.

The water passing through the aperture in the front of such a vessel, resembles a line coiling itself away as fast as the ship sails, of equal bigness with the aperture; and if it be known how much of this line the vessel, or any part of it, contains, the length of the line collected, or, in other words, the ship's distance, is had by inspection.

For example, let the aperture leading to this vessel be $\frac{1}{10}$ of an inch diameter, and the diameter of

the veſſel 300 of the aperture, then its area will be 70714, and if it is a foot and a half long it will contain 106071 feet, which divided by 6090, the number of feet in a geometrical mile, will give 17 miles $\frac{4}{10}$ nearly, or 174 tenths; and if the whole length of the inſtrument be divided into 174 parts, each part will repreſent the tenth of a mile. Let the veſſel now be put into tranquil water, with the aperture ſunk to the depth required; and when it has been an hour under, let it be taken up, and the ſurface of the internal water marked, with the inſtrument in an erect poſition :—this point is the beginning of the ſcale.

Figure I. is a repreſentation of a log upon the foregoing principle, where A is a hollow float made of copper, or light wood, about an inch thick, ſo that the difference of the aperture's depth, when the log is full, may not exceed an inch : a quantity that will give ſo trifling a difference of preſſure as need not be regarded. B the cylinder, or body of the log. C a glaſs tube, communicating with the cylinder, on which is marked the ſcale : within this

tube ſhould be a piece of black ivory, to float on the ſurface of the water, and make it diſtinct, that the quantity contained may readily be ſeen. D the aperture; which had better be made of glaſs. E a recurved pipe, coming up through the float from the cylinder, to let the air out as it fills. F a cock, to empty the cylinder. V a valve opening inwards, to prevent the water making its way out at the aperture when the log is taken up.

The above conſtruction of a log ſeemed to me tolerably perfect; the collecting a *thread* the length the ſhip had ſailed, in this eaſy manner, was ſo highly pleaſing, that I communicated it to ſeveral of my friends, but profeſs I did not meet the expected encouragement: however, I was too ſanguine to omit putting it in execution, and, in the year 1788, applied to Mr. Wright, of Leadenhall Street, to make me the inſtrument. From various circumſtances, notwithſtanding, the intended plan died away, and the work was never begun. This interval of time ſerved only to improve my former

ſcheme,

ſcheme, for there was an objection that could be obviated.—The veſſel was liable to be choked at its aperture; to remedy which, I propoſed that above the body of the log a copper cylinder ſhould be affixed of the ſame ſize, open at the fore part, but cloſed behind. This cylinder, which encircles the aperture, ſerves as a guide to an encloſed circular piece of leather, ſet out with wire hoops nearly the diameter of the cylinder, and faſtened round its bottom: at its front there is ſewed a circle of copper, which plays freely within the cylinder, altogether ſo formed as to collapſe into a ſmall ſpace, when empty, at the bottom of the cylinder. If this leather ſhould ſuffer the water to ooze through its pores it is of little conſequence, ſo long as any thing that would obſtruct the aperture is kept from entering.

FIGURE II. is a repreſentation of the log with this improvement. G the cylinder (ſuppoſe tranſparent) encircling the leather, which is here ſhewn diſtended. H a cock opening into it, by which it may be filled with water, and

ſhould

ſhould ſhut ſo cloſe as to ſuffer none to eſcape. I the copper circle.

The leather being filled with clear water, let the log be immerſed, and tracked after the ſhip; then the external water will preſs upon the copper and the encloſed water the ſame as when at liberty.

Though I have given the method of theoretically gaining the ſcale, which may ſerve as a guide to the dimenſions of the cylinder; yet, as it will be difficult to obtain exactly what proportion ſo ſmall an aperture bears to the diameter of the cylinder, and what deduction ought to be made for friction, the ſcale had better be found by experiment in water.

During my laſt voyage to India, in the Worceſter, the ſubject of logs was again reſumed: the log was ſeldom hove in my preſence, but the hope of ſeeing it improved, accompanied the heaving, which determined me to make a

ſecond

fecond application to Mr. Wright; and as he had not been encouraged to proceed with the log upon the hydroftatical principle, I offered him one upon the principle of a perambulator, which he was as little pleafed with, but promifed me the wheel, to make experiments upon, without the regifter, as this would have proved expenfive. In the courfe of converfation an allufion was made to the going round of a ventilator, which went fafter or flower with the current of air. I did not reflect much on it at the time, but fome days after, meeting with an inftrument of the kind, it occupied much of my attention. To have gained, by experiment, the number of turns fuch an inftrument would make in paffing a certain fpace through a refifting medium, would have proved too tedious; and, as it occurred to me it went upon the principle of a fpiral, I agreed to have a fpiral fixed within a cylinder, which being kept beneath the furface of the water, when drawn forward, would always have an equal volume acting againft it in the direction of its axis. The difficulty

ficulty was to regiſter the turns of the ſpiral; the mode of having a line going from its axis to wheel work on board the ſhip, being very erroneous, and inconvenient for meaſuring diſtances in a boat, it was better to have the ſpiral and regiſter of a piece, overcoming the incommodiouſneſs of carriage, and the error ariſing through the line.

Preferring the laſt, I ſtopped the progreſs of the former; and Mr. Wright alſo thinking it ſuperior to any thing I had before offered, wiſhed my meeting Mr. Grant, an ingenious mechanician, to converſe reſpecting its formation, who undertook to conſtruct the invention.

Experiment ſoon ſhewed to me the difference between theory and practice. The firſt perfect ſpiral made, was the 5100th part of a geometrical mile in length, and conſiſted of two leaves, each going through a ſemicircle in the length of the ſpiral, which, provided it had been drawn through a *perfectly reſiſting medium*, would have turned round once in paſſing through twice its length, or 2550 times in the ſpace of a mile.

However,

However, when drawn through a mile of water, this ſpiral turned only 2164 times, therefore it was neceſſary to reduce the ſpiral till it turned 2550 in a mile, which ſuited the regiſter. This was leſs labour than I conceived.—It was clear there was a proportion exiſting between the force adequate to turn the ſpiral, and the number of turns required to make up 2550; for could a ſpiral be made to turn with the leaſt poſſible force, it neceſſarily muſt go round in paſſing its length through a reſiſting medium. From theſe data the length of the next ſpiral was calculated.

DESCRIPTION OF THE PATENT INSTRUMENT.

A. Figure III. is a float four foot and a half long and two foot wide, to ſuſtain the cylinder. B, the cylinder, made of wood (which ſuppoſe tranſparent) of nine inches diameter, and placed about a foot beneath the float by means of an iron frame. In this cylinder is contained the

the ſpiral formed of copper, conſiſting of two leaves, each going through a ſemicircle in its length, and will turn 2550 times in a geometrical mile of 6090 feet. C, the worm of the axis of the ſpiral, playing in the two concentric wheels D, one having 50 teeth, and the other 51, and can be lifted out of the worm at pleaſure, to place them at zero. Between theſe wheels is a contrivance to regiſter how often one wheel has gone round the other.

ELUCIDATION OF THE REGISTER.

If the worm on the axis goes round 2550 times in the ſpace of a mile, and plays in the teeth of two wheels, running on the ſame axis, having 50 and 51 teeth, theſe wheels will differ one of their revolutions, when the worm has turned 2550 times; for the wheel of 50, in 2550 turns of the worm, will revolve 51 times; and the wheel of 51, in the ſame number of revolutions of the worm, will revolve but 50

times;

times; therefore the wheel of 50 goes round the wheel of 51 in those numbers of revolutions, which are equal to a mile; now by dividing the wheel of 50 into an hundred parts, and making a single mark on the wheel of 51, it will point out how many divisions the wheel of 50 has moved more than the wheel of 51—i. e. how many hundredths of a mile. Again, if to the wheel of 50 teeth be fixed a single tooth, to play in a small wheel of 50 teeth, running on an axis from the wheel of 51, this wheel will revolve once in 50 miles; therefore if it be divided into 50 parts, each part will represent a mile.

To set the register at zero—lift the wheels out of the worm, and placing the great wheels at the division 10, turn the smallest wheel with the thumb nail to the division 50; then putting the great wheels to 100, carefully place them, without shifting, into the worm.

Should the wheels shift a little by putting them into the worm, turn the spiral till they come exactly to 100.

I am

I am well aware there muſt be a time when the motion will not be ſufficient to overcome the friction of the ſpiral; however, the inſtrument is conſtructed to turn with ſuch freedom, that the motion muſt be extremely ſlow before this time can arrive—ſo ſlow, that its loſs will not ſenſibly affect the run.

HOW TO USE THIS LOG.

It ſhould be tracked in the ſmootheſt water about the ſhip. If the ſhip be to the wind, track it on the lee-quarter; if the wind be upon the beam, track it on the lee-beam; and if the wind be upon the quarter, track it well forward towards the lee-bow.

For meaſuring the ſhip's diſtance throughout the twenty-four hours there ſhould be two of theſe logs; one of them ſet in readineſs to be immerſed on taking up the other. This had better be done at the end of each watch; and *muſt* be done upon altering the courſe, to know

the exact distance run upon the last course; which should be marked down in miles and tenths or hundredths, breaking through the old *clumsy* custom of placing down the parts of miles in fathoms, which agrees with no table of difference of latitude and departure yet calculated.

For the purpose of conveniently getting it in and out board without danger, let an *outrigger* be fitted to each *gangway*, with a *whip* fast to the log, to draw it up clear of the side. This outrigger may be neatly formed in iron, upon the principle of a boat's davit, and fixed to the ship's side without-board, in the manner of a boat's skidds.

It will be found an advantageous instrument for surveying coasts, as it will furnish a base line at a distance from shore, where the headlands can be seen. To measure this line drop a small anchor, with a buoy and buoy-rope, equal the depth of water, to point out one end; and if there be any current, pull in its direction till the base is judged of sufficient length;

length; here drop another anchor and buoy as before, and pull back to the first, in the same time. Now the distance given by the log will be twice the distance of the two buoys from each other; for by going with the stream the log measures the distance *minus* the stream, and by going against it, the distance *plus* the stream; therefore what is lost in going is made up in returning. This will be found a more accurate method of determining a base where there is a current, than by trying the current and allowing it, which may not run equally throughout the distance; as, by following this plan, every possible velocity of the current is intercepted.

In a heavy sea it would be a considerable improvement to have a larger float, which would keep it steadier, and cause smooth water beneath for the cylinder to track in; though it would make it less commodious, yet it should be admitted for the sake of truth.

Another improvement, which may be objected to as inconvenient, is to have the cylinder a greater depth beneath the float, so that it may

track well below all floating ſubſtances, leſt it ſhould choke. All blubber, ſperm, and heterogenous matters that are met with at ſea, ſuſpended beneath the ſurface, will paſs through the cylinder. The weed called the gulf-weed, may render it uſeleſs for the time; and the rope yarn weed met with in the Engliſh channel, may prove a detriment; but theſe places, compared with thoſe where no ſuch difficulty occurs, bear but a trifling proportion.

For finding out the trim of ſhips, and for aſcertaining the beſt adapted bottom for ſailing, this inſtrument will be found extremely ſerviceable, as it informs of the leaſt difference of velocity; its principle too may be ſeveral ways employed by the experimenter.

Firſt, for ſhewing the *abſolute* velocity of the wind. Let the ſpiral be extremely light, ſuppoſe the leaves of paſteboard, and the axis of wood, together of ſuch a length as to turn 2550 times while the wind is paſſing a geometrical mile. Let a ſmall braſs worm be fixed on the axis, to turn two light wheels of 50 and

51 teeth,

51 teeth, which will regiſter 2550 turns of the ſpiral. The whole to be fixed upon a ſtaff to turn with the wind like a vane, ſo that the axis of the ſpiral ſhall lie in the direction of the wind, as repreſented figure 4. Now one obſerver is to attend the time, and another the inſtrument; the latter of whom, giving the ſpiral its liberty, is to watch the wheels coming at zero, when he is to call out, *Time!* This being noted, the wheels again at zero, he is to call, *Stop!* Then the time elapſed between the notices, is the time the wind has taken to travel a geometrical mile.

To know the velocity of the wind, for the purpoſe of getting the proper length of the ſpiral by experiment; fill a ſmall balloon made of goldbeater's ſkin, and let it be loaded till it makes nearly an equipoiſe with its bulk of atmoſphere. Now getting upon the top of ſome lofty expoſed building, make faſt to the balloon the end of a fine thread (of which there ſhould be a good quantity), and giving the balloon its liberty, note the time it is taking out a certain

portion of the thread, from which data determine the velocity of the wind.

Another application is, to meaſure the depth of the ſea in thoſe parts where the depth is ſuch as renders it impoſſible to be done by line. For this purpoſe it is only ſtripping the log of its float, and making faſt to the wheel end a globe of light wood, ſufficient to float the inſtrument in an erect poſition; and at the other end, having a long ſlit through a piece of braſs, A, figure 5, extending from the centre; in which ſlit is fixed a ſpring hook to hold a weight, in the form of a globe, heavy enough to ſink the whole. This being put into the ſea deſcends in an erect poſition, the ſpiral turning as the ſpace paſſed through, and the wheels regiſtering the turns till it arrives at the bottom, when the weight ſtriking, and the other yet continuing to deſcend, the hook flies back into the poſition of the dotted hook B, clear of the weight, and the inſtrument is at liberty to riſe; but as in riſing it would undo what it had regiſtered in deſcending, there is a ratchet to prevent

the

the ſpiral turning back, ſo that the diſtance ſhewn at its coming to the ſurface is the exact depth of the ſea.

This laſt-mentioned application may only be uſeful to the philoſopher, but the firſt will afford the ſeaman an opportunity of being acquainted with the exact force of the wind againſt his ſails; for when ſuch an inſtrument is uſed on ſhipboard, it will give the velocity and direction of the wind as compounded with the ſhip's motion, and together with the log is neceſſary to the more perfect diſcovery of the ſhip's trim.

It is needleſs to mention the inaccuracies of the common log, the errors of which have led ſeamen into the greateſt abſurdities. Some have ſhortened the glaſs, and others have lengthened the line, upon finding the difference of latitude, by obſervation, not to agree with the difference of latitude by account; without adhering to any ſtandard, making a mile upon the earth's ſurface ſometimes one meaſure, ſometimes another. Others again have a *magical* manner of adding up a log-board. For inſtance, I ſailed

with a commander who had his log-line meaſured eight fathom a knot to a 28 ſecond glaſs, not a bad proportion; but when the fathoms were caſt up, inſtead of finding how many times eight they contained to carry to the knots, his general orders were, to find how many times ſeven, which in two boards abſolutely of the ſame length (with this difference, that the one be made up of whole knots, and the other partly of fathoms) will make a moſt material alteration.

The imperfections of the patent log are—firſt, it gives the direct diſtance increaſed by the yawing of the ſhip, and ſecondly increaſed by the difference between the curve of the ſea and a ſtraight line. If the angle of yaw continued the ſame, the firſt error would be equal to the natural verſed ſine of it; but as it is increaſing, and forms a curve, one end of which is in the direction of the courſe, and the other in the direction of the extreme angle of the yaw, the difference between this curve and the direct diſtance will be the ſum of a ſeries of natural

verſed

verſed ſines, from no degrees to the greateſt yaw. Here follows a table, conſtructed upon the above principle, which gives the quantity to be deducted, on account of the yawing of the ſhip, in each ten miles run, to hundredths of a mile, from a quarter of a point up to three.

Points of yaw.	Hundredths of a mile to ſubtract.
$\frac{1}{4}$	,00
$\frac{1}{2}$	,01
$\frac{3}{4}$	,02
1	,04
$1\frac{1}{4}$	,07
$1\frac{1}{2}$	,11
$1\frac{1}{3}$	,17
2	,24
$2\frac{1}{4}$	,34
$2\frac{1}{2}$	,46
$2\frac{3}{4}$	,60
3	,77

The ſecond error is chiefly done away by tracking the log in the ſmooth water to leeward of the ſhip, and when the wind is aft with a high following ſea, the ſhip is thrown forward. Now the more ſea, the greater diſtance this log will give, as the curve of the wave increaſes; and it poſſibly may be, that the ſhip is thrown forward in the ratio of increaſe of the curve; if ſo, this error is entirely corrected.

Some

Some ſeamen, I know, will object to uſing this log, thinking it will impede the ſailing.—Granted; but where is the accurate obſerver who will inform me of the quantity! It is not a trifling impediment that will make an alteration of velocity perceptible; an inſtance of which follows, that occurred in the Worceſter Indiaman. Coming up Channel, we took on board, from a Dover cutter, a Mr. Lattimore as pilot; and, as it blew freſh, he begged a tow-rope might be given to his veſſel, fearing ſhe would not be able to keep up with the ſhip. For this purpoſe, the end of a nine inch hawſer (only once before uſed, to my knowledge) was given out to her through the larboard gun-room ſcuttle. The wind freſhened, and at four in the morning the weight of the cutter broke the hawſer: the ſhip was then going nine and a quarter knots per hour, and throughout the voyage, I think it will be found, that her utmoſt rate of ſailing was never more than nine and a half: the hawſer was not chafed, and the yarns were perfectly freſh and ſound.

By

By allowing the hawſer to contain 393 yarns, and each yarn to be capable of ſuſtaining an hundred weight, the force pulling at the ſtern was about 20 tons, and the difference from her utmoſt known velocity only a quarter of a mile, which quantity might be given through error in heaving the log; or perhaps, had the hawſer not broke, and the ſail remained unreduced, the ſhip might have increaſed her way ſo much, as that no one could have aſſerted, the cutter made a perceptible alteration.

As the perpetual log may not be found convenient when turning to windward, or when it is neceſſary to be continually altering the courſe, a ſmaller log is contrived upon the ſame principle, to give the rate of ſailing for any inſtant of time. The proportion is $304\frac{1}{2}$ feet a knot to a three minute glaſs. This gives it a conſiderable ſuperiority over the common log, which, when the velocity is great, can only be uſed

with

with a quarter minute glaſs, on account of the length of line that otherwiſe would be taken out; and, as the line run out in a quarter of a minute bears a very ſmall proportion to the diſtance run in an hour, it is ſcarcely poſſible to gain by this method the rate of ſailing to a half mile, which ſeamen, who have attended to the heaving of the log, muſt be well acquainted with.

DESCRIPTION OF THE SMALLER PATENT LOG.

The float, ſpiral, and cylinder, have half the dimenſions of the perpetual log. The wheels are 50 and 51 teeth, and will regiſter 3045 feet. Now allowing $304\frac{1}{2}$ feet to the knot, to a three minute glaſs the wheels will regiſter ten knots, into which number of parts the wheel of 50 is divided, and each part ſubdivided into ten. There is a contrivance to prevent the wind turning round the ſpiral till it is immerſed in the water.

METHOD

METHOD OF USING IT.

Let there be an *outrigger* at the lee-gangway with a *whip*, and a rope from forward of ſufficient length to reach aft, and ſuffer the log to track abreaſt of the *outrigger*—the rope and *whip* being faſt, with a hand to attend it, let the log drop, and turn the glaſs; when the glaſs is out, then whip up the log.

I cannot too much recommend care and attention to be paid to theſe inſtruments; the ſpirals muſt be often examined, for, ſhould they get bent from their proper ſhape, the diſtance given will be erroneous: when they are to be laid aſide for a time, let the wheels be taken aſunder and thoroughly dried. Never ſuffer either cylinder or float to want paint, particularly the float, otherwiſe the water penetrating into the wood will make it heavy.

Before I quit this ſubject, I muſt mention a log which would be very ſerviceable when

paſſing along coaſts or through ſtraits. For want of an inſtrument of this kind, charts drawn from journals muſt be exceedingly erroneous if the current is not known.

This log gives the abſolute diſtance ſailed, and the courſe made, compounded of the ſhip's motion and current. A, Figure 6, is a light circular piece of wood, about 10 inches diameter, with a hole in the middle for the *ſtray-line* of the log to paſs through, to the end of which line is a lead of five or ſix pounds. The lead being cloſe up to the wood, A, they are thrown overboard together, and the *ſtray-line* paſſes through the whole till the lead reaches the bottom, which anchors the wood perpendicularly over it: the *ſtray-line* out, turn the glaſs, and proceed as if heaving the common log. Before the log is hauled in, take its bearings, the oppoſite point to which is the ſhip's courſe, clear of lee-way and current. If in the hole of the circular piece of wood were fitted a gentle braſs ſpring to bind againſt the line, it would be more perfect. There ſhould

be

be a good quantity of *ſtray-line*, taking care that it is even, and the ſplices neat long ſplices, no bigger than the line. Let the line be marked 50 feet nine inches a knot to a half minute glaſs. While the ſhip's way does not exceed four or five knots, it would be better to double this proportion, and let the diſtances between the knots be an 101½ feet to a minute glaſs.

Being now out of employ, by my not having been fortunate enough to procure a ſtation on board any of the Eaſt India Company's ſhips for the paſt ſeaſon, I have it in contemplation to make a ſhort voyage, merely for the purpoſe of a more full inveſtigation of the patent inſtrument. There may be circumſtances, particularly reſpecting the float, which do not occur with a ſmooth water trial, that a high ſea may be the means of diſcovering: ſhould I undertake this voyage, on my return the earlieſt information ſhall be given of the inſtrument's performance.

Gratitude will not permit me to conclude without returning thanks to my ſincere friend

and preceptor Mr. John Adams of Edmonton, who kindly aſſiſted me in moſt of the experiments made with the perpetual log, and to whom I am much indebted for ſeveral valuable hints.

THE END.

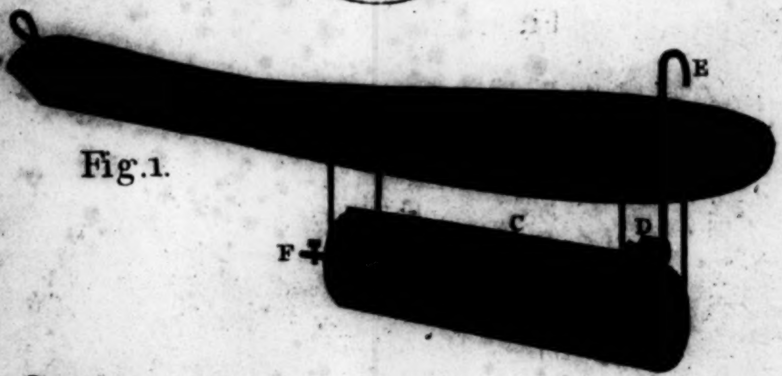

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

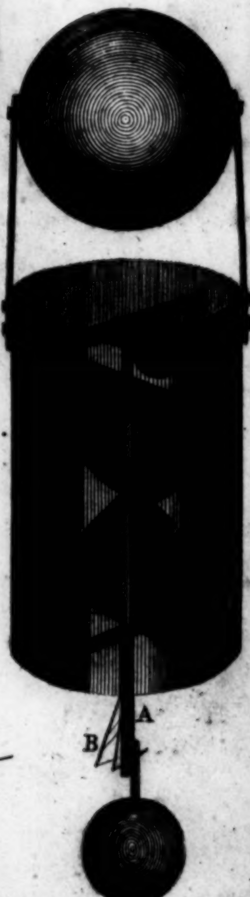

Fig. 6.